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Contributions to the knowledge of North American Sphagna. I.

C. WARNSTORF.

During the past ten years the North American peat-mosses have been repeatedly elaborated. In the year 1882 appeared a work by Lindberg under the title, Europas och Nord-Amerikas Hvitmossor (Sphagna), in which he describes 21 species and 3 subspecies for both continents. Of these *S. cyclophyllum* Sulliv., *S. macrophyllum* Bernh., *S. cribrosum* Lindb., *nov. sp.*, and *S. Portoricense* Hpe. belong exclusively to North America, *S. Angstræmii* Hartm. only to Europe, while the remaining species are common to both continents. Three years later (1885) Miss Clara E. Cummings published in a catalogue of the Musci and Hepaticæ of North America north of Mexico 27 species of Sphagnum. Among these *S. Muelleri* Schpr. and *S. molle* Sulliv., *S. sedoides* Brid. and *S. Pylaiei* Brid., *S. rigidum* Schpr. and *S. Garberi* Lesq. & James are identical, wherefore only 24 species remain. Finally, in Révision des Sphaignes de l'Amérique du Nord (1887), Jules Cardot admits 16 species; the following species, *S. medium* Limpr., *S. papillosum* Lindb., *S. Austini* Sulliv., *S. affine* Ren. et Card., *S. laricinum* Spruce, *S. squarrosus* Pers., *S. Girgensohnii* Russ. and *S. cuspidatum* Ehrh., are considered by him as subspecies. Cardot seems perfectly justified when he designates the *S. cribrosum* Lindb. as *S. Floridanum* (Austin), for this fine, characteristic species was distinguished in 1880 by Austin as *S. macrophyllum* var. *Floridanum*. Cardot had not seen *S. Garberi* Lesq. & James, but conjectured that it might be only a form of *S. rigidum* Schpr. A specimen which I have received from the Kew Herb. (England) has fully confirmed this opinion of Cardot; *S. Garberi* is only a squarrose form of *S. compactum* DC.

When now I attempt in the following pages to present a review of all the known species and varieties of the North American peat-mosses, I wish to state that the chief inducement to do this comes from Mr. Edwin Faxon, of Boston. He has during the past year, and even earlier, with unwearied industry and commendable perseverance, made a systematic collection of the Sphagna of Massachusetts and

New Hampshire particularly, and has had the kindness to send to me about 500 numbered specimens. Among these are several new species of the *Acutifolium* group, which have been recently established by Prof. Russow or by myself, respectively, or by us jointly. In order to make these known among North American bryologists I shall fully describe them in the following pages. Furthermore, in Mr. Faxon's collections are found numerous specimens of *S. affine* Ren. et Card. whereby I am enabled to make perfectly clear the position of this species in the system.

I. *Sphagna acutifolia*.

A. *Stem leaves with completely resorbed cell-membranes in the upper part.*

- a. Stem leaves widening upward, spatulate, the apex and a part of the upper margins lacerate-fringed.

1. *S. fimbriatum* WILS. in Hooker Fl. Antarct. p. 398 (1847).

Syn.: *S. subulatum* Bruch in Herb. Kew.

Of this species I have hitherto seen from N. America two forms:

Var. *tenue* GRAVET. Tufts usually loose, green or whitish-green; plants graceful and slim, with long slender spreading branches.—Mass., Boston and Brookline, 100 feet; N. Hampshire, White mountains, 2,000 feet (*Faxon*); Miquelon Island (*Delamare*); N. Jersey (*White*); Cal., Sierra Nevada (*Brewer*).

Var. *arcticum* C. JENSEN. In firm compact whitish tufts. Stem with short, thick-set, ascending to upright, stouter branches.—Greenland: Mission station, New Herrenhut (*Spindler*).

- b. Stem-leaves not widening upward, linguiform, and only at the apex lacerate-fringed.

2. *S. Girgensohnii* Russ. Beitr. p. 46 (1865).

Syn.: *S. acutifolium* ϵ *tenue* Bryol. Germ. I. p. 22 (1823).

S. fimbriatum, var. *majus* A. Braun in Herb.

S. fimbriatum, var. *strictum* Lindb. Torfm. byggn. p. 138 (1862).

S. strictum Lindb. in Act. Soc. Sc. Fenn. 10, p. 263 (1872).

S. Hookeri C. Müll in Linnæa, 1874, p. 547.

S. leptocladum Besch. in Herb. Mus. Paris (1877).

S. acutifolium, var. *fallax* Warnst. in part, in Europ. Torfm. p. 42 (1881).

S. Warnstorffii Röll in part, in Syst. d. Torfm. Flora (1886).

This species is already known to inhabit Canada, New Hampshire, Massachusetts, New Jersey, and Miquelon Island (*Delamare*). How Cardot can decide to include this fine characteristic species as a subspecies of *S. acutifolium* (Ehrh.) I can not comprehend. Quite as properly might he also have considered *S. fimbriatum* as belonging to *S. acutifolium*. Both species are surely specifically distinct from *S. acutifolium* by the numerous pores in the stem cortex, by the occurrence of resorption in the stem leaves, as well as by the quite different pore structure of the branch leaves. *S. Girgensohnii* is very widely diffused in the northern parts of the northern hemisphere. I have a specimen from Japan (Herb. Mitten), which is monoicous. *S. Hookeri* C. Müll. from the Himalaya is only a very delicate squarrose-leaved form of this species, and in anatomical structure agrees perfectly with *S. Girgensohnii*.

The most important of the forms received from Mr. Faxon are the following:

Var. **coryphaeum** Russ. in Warnst. Samml. Europ. Torfm. Serie I. no. 26 (1888).

Plants 15–50 cm. long, usually of a vivid green, light or dark, frequently dirty rust color to almost black in the lower parts. Coma usually beautifully stellate, more or less compact, either wide-spread umbrella shaped or flat-arched. Branches of the coma usually a little thickened to the end, sometimes very considerably so, more or less obtuse. Usually mesocladous, rarely macro- or brachycladous; homalo-, drepano- and catocladous, never ortho- nor anocladous; frequently eurycladous. In loose, deep tufts in very damp, mostly in quite wet situations, in pine or mixed forests. Stem leaves of medium size, generally brachyphyllous, length and breadth equal, or broader than long, rarely in some forms a little longer to a half longer than broad, usually from the broad base narrowed upward and at the apex slightly truncate and fringed. Median basilar (hyaline) cells usually much spread out [sehr stark gespreizt], never with pseudo-fibres, never hemiisophyllous. Pores of the cuticle large, numerous, bordered, or oftener not bordered. Comparatively abundant in fruit.—New Hampshire, White Mountains, 1,500 to 4,500 feet; Mass., Milton, 500 feet (*Faxon*).

Var. **stachyodes** Russ. in Warnst. Samml. Europ. Torfm. Ser. I. no. 50 (1888).

Plant 8–30 cm. long or more, slender to very robust,

usually in cushion-like tufts of small extent, prevalent in swamps of birch and alder intermixed with pines, on the borders of forests, into the depths of which it seldom penetrates, and preferring the comparatively dry situations. Of a spike-like habit, uniformly branched throughout the whole length, the coma not broader than the rest of the plant, comal branches usually penicellate-radiate. Homalo-, ano-, ortho-, and drepanocladaous. Pale green, grayish green, often yellowish green to yellow-brownish, rarely vivid green. ♂ branches not clavate-thickened, rusty yellow. Stem leaves of medium size to small, rarely over medium size to almost large, mesophyllous, sometimes macrophyllous (length nearly twice the breadth); apex usually broad-truncate and fringed; for the most part with pseudo-fibres. As yet unknown in fruit.

Mt. Washington, N. H., 5,000 ft. (*Faxon*).

Var. **molle** Russ. in Warnst. Samml. Europ. Torfm. Series II, no. 115 (1890). Plants 5–15 cm. long and more, soft and delicate, bright- to rather dusky-green, sporting into yellowish and brownish tints to dusky brown-yellow, also bluish- or grass-green, below darker colored; meso- to macrocladaous, usually drepanocladaous, also homalo- and catocladaous, eury- and dasycladaous; forming rather extensive tufts in low wet grassy places in alder and birch swamps. Stem leaves of medium size to small, mesophyllous to narrow-mesophyllous; often with pseudo-fibres; hemisophyllous forms are not rare; sometimes there are transitions to *stachyodes* and *leptostachys*.

New Hampshire, Profile Lake, Franconia, 2,000 ft. (*Faxon*).

B. *Stem leaves nowhere with completely resorbed cell-membranes and therefore usually dentate at the apex.*

a. Stem leaves slightly or not all narrowed upward, with rounded often cucullate apex, which is sometimes delicately fimbriate, linguiform, the broad border much widened downward.

α. Stem leaves large, broad-linguiform, usually wholly destitute of fibres and pores, only in the middle of the apex dentate or slightly fimbriate, hyaline cells in the upper part of the leaf rhombic with numerous membrane-plaits; not every one of the superficial cells of the stem cuticle with one pore; pores without rings; usually dioicous rarely monoicous, ♂ branches red.

3. *S. Russowii* WARNST. in Hedwigia, 1886, p. 225.

Syn.: *S. acutifolium*, var. *robustum* Russ. Beiträge, p. 39 (1865).

S. acutifolium, var. *roseum* Limpr. Milde, Bryol. Sil. p. 382 (1869).

S. acutifolium, var. *fallax* Warnst. in part, Europ. Torfm. p. 42 (1881); var. *polyphyllum* Warnst. Flora, 1882, p. 206; var. *decipiens* et *flagelliforme* Grav. in litt. (1883); var. *strictiforme* Warnst. Flora, 1883, p. 373.

S. auriculiforme Schlieph. et Warnst. var. *auriculatum* Warnst. Hedw. 1884, p. 117; var. *elegans* Schlieph. in litt. (1884).

S. Girgensohnii var. ϵ *roseum* Limpr. Kryptogamenfl. v. Deutschl. 4. Bd., p. 109 (1885); var. *majus*, Röhl in litt. ad Schlieph. (1885).

S. Wilsoni Röhl, var. *roseum* (Limpr.) Röhl, Syst. d. Torfm. in Flora, 1886.

S. Warnstorffii Röhl, var. *auriculatum* (Warnst.), var. *strictiforme* (Warnst.), var. *polyphyllum* (Warnst.), var. *fallax* (Warnst.) in part, f. *deflexa* Röhl, f. *squarrosa* Röhl, f. *teres* Röhl, var. *strictum* Röhl, var. *fimbriatum* (Warnst.) Flora 1886; var. *pseudo-strictiforme* Röhl in litt., var. *tenellum* Röhl in litt.

S. robustum (Russ.) Röhl, Flora, 1886, (all forms?).

General habit and color quite variable. Plants usually tall and strong, of the size of *S. Girgensohnii*, and also much resembling it; tufts loose and high or compact and low, whitish, yellowish green, pure green, brownish yellow, violet-, rose- and purple-red. Wood cylinder of stem, usually red, more rarely whitish. Stem cortex variably formed of 2-3 or 3-4 strata of cells, the superficial cells with isolated, irregularly distributed, small or large pores without rings; the inner cells with numerous small pores. Stem leaves large, broad linguiform, with somewhat undulate margins, only in the middle of the broad rounded apex dentate or somewhat fimbriate, the border much widened below. Hyaline cells in the upper part of the leaves large, broad, rhombic, mostly without cross-partitions, but with delicate membrane-plaits, all the hyaline cells with membrane thinnings, which rarely at the edges towards the apex change into isolated pores; mostly without fibres and pores, but rarely fibrose near the apex.

Fascicles 4 or 5 branched, distant or crowded, 2 or 3 stouter branches spreading, recurved, horizontal, curving upward or erect, longer or shorter, the pendent branches very long and closely appressed to the stem. Retort cells of the branch cortex with neck slightly bent outward, with always a large pore at the summit; often, also, with one in the middle. Branch leaves closely or loosely imbricated, mostly with a somewhat spreading, more rarely nearly squarrose, tip, very seldom almost secund, lanceolate, narrowly bordered, the upper margins involute, and at the transversely or roundly truncate apex dentate; with 2 or 3

plaits near the base, and the hyaline cells with plicate membranes. Pore-structure on both sides of the leaf similar to that of *S. Girgensohnii*, like that, also, having numerous large pores on the inner side of the apical half and near the margins. Chlorophyllose cells in cross-section isosceles-triangular to parallel-trapeziform, placed on the inner side of the leaf between the here slightly convex hyaline cells and free, enclosed on the outer side by the here much more convex hyaline cells, or free.

Dioicous, rarely monoicous. ♂ branches in the antheridium-bearing part clavate-thickened, always violet- or purple-red; perigonial leaves in form and in the structure of cells and pores not different from the rest of the branch leaves, mostly fibrillose to the base, more rarely with single cells near the base not fibrillose. Perichæial leaves as in *S. Girgensohnii*, sometimes red. Spores dimorphous; microspores in separate smaller capsules, globular, without polyhedron-faces (always?), smooth and yellow, 0.012–0.013 mm. diam.; macrospores 0.021–0.025 mm. sometimes 0.031–0.033 mm. diam., also smooth and yellow. Fruit rare.

Var. *pæcilum* Russ. *in litt.* (1887).

The forms belonging here are distinguished by a very dull violet-red beef-color. In some the violet is pure, handsome and bright, in others dirty and faded, in others the red is pure without admixture of blue. In the whole var. *pæcilum* there is added to the violet or violet-red a bright or pale grayish green, now clear now clouded.

N. Hampshire, Crawford's, 1,900 ft., Franconia Notch, 2,000 ft.; Vermont, Westmore, 1,100 ft. (*Faxon*).

Var. *rhodochroum* Russ. *in litt.* (1887).

This series of forms is distinguished by a mixture of yellow or yellowish green with clear, delicate brick-red or almost rose-red; from this red, which is usually clearly impressed on the lower parts of the plant, the red of the male branches is plainly distinguishable, the latter always showing an admixture of blue with the red.

N. Hampshire, Crawford Bridle Path, 4,000 ft. (*Faxon*).

f. *dasy-anoclada* WARNST. Tufts extremely dense; spreading branches comparatively short, much crowded and ascending.

N. Hampshire, Crawford bridle-path, 4,000 ft. (*Faxon*).

Var. *Girgensohnioides* Russ. *in litt.* (1887).

This variety includes all the forms in which green predominates and which show, in greater or less degree, only a

very slight admixture of red. Those forms that show a greater proportion of red, but whose green perfectly agrees with that of *Girgensohnioides*, Russow has united in the sub-var. *intermedium*.

N. Hampshire, Mt. Washington, 4,000–5,000 ft., Mt. Lafayette, 4,000 ft., Franconia, 1,300 ft.; Vermont, Westmore (in fruit), 1,100 ft. (*Faxon*).

Var. **obscurum** Russ. *in litt.* (1887) as sub-var.

In the forms belonging here the tints are always smirched; the plants exhibit a clouded coloration which is produced by a mixture of dark dirty violet, brown and gray.

N. Hampshire, Mt. Washington, 5,000 ft., Mt. Willey, 2,500 ft. (*Faxon*).

β. Stem leaves smaller, linguiform, delicately fringed at the rounded apex, or abruptly contracted to a small cucullate point, nearly always without fibrils and pores. Superficial cells of the stem cuticle without pores; wood cylinder always reddish brown, as is frequently the whole plant; dioicous; ♂ branches brownish.

4. *S. fuscum* (SCHPR.) VON KLINGGRAEFF. Besch. d. i. Preussen gef. Arten u. Varr. d. Gatt. *Sphagnum* (Schrft. d. Phys-öc. Ges. i. Königsberg 13, P. I. p. 4, n. 4, 1872).

Syn.: *S. acutifolium*, var. *fuscum* Schpr. Entw.-Gesch. d. Torfm. p. 57, t 13, fig. E (1858).

S. acutifolium, var. *fuscum* (Schpr.) Schlieph. et Warnst. Flora, 1884.

In extensive, dense or loose, often cushion-shaped patches. Color usually a peculiar grayish green intermixed with brown or reddish brown, more rarely whitish or green. Stem taller or shorter, according to the station, usually slender and delicate like *S. tenellum* and *S. Warnstorffii*.

Wood cylinder always reddish brown, with very thick-walled pith-cells.

Stem cortex variably formed of 3–4, rarely to 5, strata of thin-walled cells of medium width; superficial cells not perforated on the outside; inner cells with small pores.

Stem leaves usually small, linguiform; often at the rounded apex abruptly contracted to a small cucullate point, which is generally somewhat fimbriate; the broad border much widened downward. Hyaline cells nearly always without fibrils and pores; very rarely with rudimentary fibrils below the apex; 2 to 4 times divided by obliquely transverse walls, and with delicate longitudinal plaits in the membrane; basal cells saccately dilated downward.

Fascicles consisting of 3 or 4 branchlets, of which the stouter are sometimes long and much attenuated to the apex, sometimes shorter and abruptly pointed. Branches distant, or closer, or crowded, either falcately bent downward, horizontally spreading, curved upward, or strictly erect.

Branch leaves small, nearly lustreless when dry, densely or loosely imbricated, from an ovate base extending to a comparatively short, round-truncate, dentate, involute tip; bordered by 3 or 4 rows of narrow cells; a plait in the middle near the base. Hyaline cells on the inner side of the leaf, in the upper part, with numerous usually ringless pores, especially in the upper and lower cell angles; in the vicinity of the lateral margins of the leaf as well as directly over the base the pores are in the middle of the cell-wall, between the fibrils. On the whole outer side of the leaf the hyaline cells have numerous apertures which, at the apex of the cell, are small and strong-ringed, and below become gradually larger and weaker-ringed. In the lowest part they are very large and without rings, and are situated in the middle of the cell wall between the fibrils, while the rest are on the commissures. Near the edges the pores on the two sides of the leaf are partly opposite each other, so that at these points more or less complete perforations of the leaf occur.

Chlorophyllose cells in cross-section triangular to isosceles-trapeziform, placed between the hyaline cells on the inner side of the leaf and always free; on the outer side, sometimes enclosed, sometimes free, and here the hyaline cells are more convex.

Diocious; ♂ branches very similar to the sterile, slightly or not at all thickened in the antheridium-bearing portion, here always yellowish brown, after flowering lengthening at the tips; perigonial leaves very small, sharply contrasted to the lower sterile leaves of the male branch, broad-oval, denticulate at the rounded apex. Pore structure like that of the other branch leaves, the lower half or two-thirds (rarely the whole leaf), without fibrils and pores. Fertile branches mostly short; perichætal leaves large, ovate, slightly emarginate at the rounded apex, broadly bordered, in the lower part with elongated, rectangular, pitted chlorophyllose cells, higher up with both kinds of cells of which the hyaline are once to four times divided by obliquely transverse walls, and at the apex with narrow, short chlorophyllose cells; always without fibrils and pores. Fruit rare; spores golden yellow, granulate or nearly smooth, 0.025–0.030 mm. diam.

Sphagnum fuscum is a genuine high-bog plant, and surely, in suitable localities in Canada and the northern United States, as in Europe, not rare.—Miquelon Island (*Delamare*.)

Var. *fuscescens* WARNST. Tufts brown throughout, almost entirely without admixture of green, the coma some times even reddish brown.

N. Hampshire, Mt. Washington, 5,000 ft. (*Faxon*).

f. *robusta* WARNST. Plants very stout and tall, with rather long, usually deflexed branches. Tufts dense or loose.

Vermont, Westmore, 1,100 ft. (*Faxon*).

f. *dasy-anoclada* WARNST. In extremely firm, compact, and often very deep patches. Stem with very thickly set, short, ascending branches.

New Hampshire, Mt. Lafayette, 4,000 ft. (*Faxon*).

Var. *fusco-viride* (RUSS.) as *forma*.—Color of the tufts a mixture of green and brown. Sometimes the green predominating; sometimes the brown, but always blended.

N. Hampshire, Mt. Lafayette, 4,000 ft., Lisbon, 1,000 ft.; Mass., Mt. Graylock, 1,500 ft. (*Faxon*).

f. *robusta* WARNST. s. f. *drepanoclada* W.—Plants extremely stout and tall, loosely cespitose, in the upper part the green most prominent, the coma and the lower part browner. Branches long, rather distant, falcate-reflexed.

Mass., Dedham, 100 ft. (*Faxon*).

γ. Stem leaves now larger now smaller, usually cucullate at the apex through involution of the edges. Hvaline cells multipartite, nonfibrillose or in the upper part fibrillose. Branch-leaves frequently secund; wood cylinder of various colors but never brown; usually dioicous, rarely monoicous; male branches red.

5. *S. tenellum* (SCHPR.) VON KLINGGRAEFF Besch. d. i. Preussen gef. Art. u. Varr d. Gatt. *Sphagnum* (Schrft. d. Phys.-öc. Ges. i. Königsb. 13, P. I, p. 4, n. 5, 1872.

Syn.: *S. rubellum* Wils. Bryol. Brit. p. 19, tab. 60 (1855).

S. acutifolium γ *tenellum* Schpr. Entw.-Gesch. d. Torfm. p. 57. ta. b, 13.

fig. γ (1858).

S. acutifolium, var. *rubellum* Russ. Beits. p. 41 (1865).

S. acutifolium, var. *tenue* Braithw. (1880).

S. acutiforme varr. *tenellum* et *rubellum* Schlieph. et Warnst. Flora, 1884.

S. Wilsoni Röhl, in part, *S. acutifolium*., var. *elegans*, f. *plumosa* Röhl in Flora, 1886.

S. Schimperii, varr. *tenellum* et *gracile* Röhl (1886).

Tufts soft, looser and taller or denser and shorter. Color quite variable, whitish, yellowish, green, rose-red or violet. Plants generally quite slender and soft, of the stature of *S. Warnstorffii* or *S. fuscum*.

Wood cylinder whitish or reddish; pith-cells thick-walled.

Stem leaves larger or smaller, linguiform, usually cucullate-incurved at the apex and sometimes at the sides, and afterward by spreading out flat becoming lacerate, dentate or delicately fimbriate; the broad border much widened downward; the margins slightly undulate. Hyaline cells with or without fibrils in the upper half of the leaf, two to four times (rarely six times) divided by obliquely transverse walls, and with delicate membrane-plaits.

Stem cortex formed of 3 or 4 layers of thin-walled cells of medium width, their outer walls not porose.

Fascicles distant or approximate consisting of 3 or 4 branches, of which the two stoutest diverge in various directions from the stem and are variable in length. Retort cells of the branch cortex with distinctly recurved neck and with an aperture at the apex. Branch leaves loosely or densely imbricated, frequently secund, ovate to ovate-lanceolate and small, dentate, at the broad rounded apex, edges involute; margin bordered by 2 or 3 rows of narrow cells; with a longitudinal plait in the middle over the base, and the membranes of the hyaline cells with numerous plaits. The apical half of the inner surface of the leaf with numerous small pores, especially in the upper and lower cell-angles, and larger ones in the broader part of the leaf, especially near the margins; outer surface of leaf quite covered with pores which, in the apex, are strongly ringed and a little smaller than in the middle of the leaf, at the base very large and ringless, singly in middle of the cell-walls between the fibrils; near the edges situated, in part, opposite the inner pores and thereby producing complete perforations of the leaf.

Chlorophyllose cells in cross-section as in *S. fuscum*.

Dioicous, rarely monoicous; male branches in the antheridium-bearing portion always purple- or violet-red; perigonial leaves ovate, contracted to a small, rounded, denticulate, cucullate point; in the lower part without fibrils and pores. Perichæatial leaves large, ovate, above abruptly contracted to a narrow truncate emarginate involute point; either formed in the lower part of pitted chlorophyllose cells only,

or, throughout the whole leaf except the apex, of both kinds of cells. Hyaline cells many times divided by transverse, oblique or longitudinal walls, and without fibrils and pores; the apex of the leaf formed entirely of short, narrow, thick-walled, pitted chlorophyllose cells. Margins broadly bordered. Spores dimorphous; microspores yellowish brown, polyhedral, 0.012–0.015 mm. diam. in smaller urn-shaped capsules. Macrospores according to Limpricht ochre-colored, size? Fruit very rare!

S. tenellum is, like *S. fuscum*, a plant of the elevated bogs, and should be found in suitable situations in Canada and in the northern parts of the United States as abundantly as in Europe.

Miquelon Island (*Delamare*).

Var. *rubellum* (WILS. *as species*).—Whole plant, especially in the upper part, pale-, rose- or purple-red to purple-violet, in the lower parts fainter but without admixture of green. Branch leaves frequently secund.

Mass., Boston and Brookline, 100 ft. (*Faxon*). Danvers, 100 ft. (*Sears*).

Var. *versicolor* WARNST.—Color a mixture of red (pale rose, violet red) and green; the former more especially in the coma, the latter in the other parts of the plant; the two colors very unequally distributed, now the red, now the green predominating; the lowest parts of the plants bleached out.

Mass., Boston, Brookline, Dedham, 100 feet (*Faxon*).

Var. *viride* WARNST.—Whole plants grayish or vivid-green, almost without a trace of red; the male branches violet-red.

Mass., Boston, Brookline, 100 feet (*Faxon*).

Var. *pallescens* WARNST. Plant above usually whitish, or faint yellowish green, in the middle sometimes light brownish or extremely faint reddish; male branches sordid violet.

N. Hampshire, Mt. Willey, 2,500 feet; Mass., Brookline, 100 feet (*Faxon*).

- ♂. Stem leaves small, linguiform, hyaline cells less divided, non-fibrillose or only near the apex faintly fibrillose. Branch leaves often distinctly five ranked, mostly curved erect-spreading, rarely in part slightly secund; the lower and middle leaves with very small, round, strongly-ringed pores on the outside in the upper half. Wood cylinder variously colored, but never brown. Dioicous; ♂ branches red.

6. *S. Warnstorffii* Russ. in Sitzungsber. der Dorpater Naturforscher-Ges. Jahrg. 1887, p. 315.

Syn.: *S. acutifolium*, var. *gracile* Russ. Beitr. p. 44 (1865).

S. acutiforme, var. *tenellum* Schlieph. et Warnst., in part, Flora, 1884.

S. acutifolium, var. *Graefii* Schlieph. in litt. (1885).

S. Wilsoni Röll var. *tenellum*, f. *purpurea* Flora, 1886.

Tufts mostly loose, of greater or less extent, concolorous, light to dark green or yellow-whitish, reddish, violet- to dark purple-red, or often variegated by a mixture of green and red, or of a yellowish white and red. Plants usually delicate, slender and graceful, at the same time firmly erect, rarely weak; of various forms of growth: usually brachy-, eury-, homalocladous, seldom anocladous, never orthocladous, not rarely dasy-, drepano-, catocladous, seldom squarrose. Stem upright, slender, 3-15 cm. long.

Wood cylinder well developed, constructed of much thickened cells, usually reddish or violet to dark red, seldom colorless or greenish.

Stem cortex of 2 to 4 (very rarely 5) strata of cells; the inner cells relatively much thickened, and with numerous pits, the outer without pores, very seldom with a few here and there.

Stem leaves small to medium size, 0.40 to 1.50 mm. long, mostly linguiform, from the base very gradually narrowed and then rather abruptly contracted into a roundish-pointed dentate or entire apex; the narrow border much widened downward as in *S. acutifolium*. Hyaline cells in the upper half of the leaf rhombic to elongate-rhombic, mostly divided, sometimes into 3 or 4 daughter-cells, nonfibrillose, or not rarely with a few very delicate fibrils. in the former case with longitudinal plait.

Fascicle formed of 3 to 5 branches, of which 2 or 3 are spreading. Leaves of the latter ovate in the basal half, thence extending with involution of the margins into a subulate 3 to 5 toothed truncate point; the leaves are often very regularly five-ranked, sometimes secund, always with their points diverging from each other; those of the pendent branches like those of the apical half of the spreading branches narrowly ovate to lanceolate, those at the base of the pendent branches broadly ovate.

The hyaline cells of the leaves of the basal half of the spreading branches are furnished on the outer surface with numerous pores, which in the upper half of the leaf are externally small, nearly round and very numerous and encir-

cled by a relatively broad, stout fibril-ring ; the pores which occur in the lower half of the leaf, on the contrary, are large, oval and not numerous. In the leaves of the apical half of the spreading branches, and of the whole extent of the pendent branches, the pores gradually diminish in size from the base to the apex of the leaves, and the small pores of the apex are much larger than the corresponding ones in the leaves first mentioned. Pores on the innerside of all the leaves more numerous in the lower part of the leaf and near the margin, large, mostly destitute of rings, and in part opposite to the outside pores, whereby complete perforations of the leaf often occur.

Chlorophyllose cells placed on the inner side of the leaves, and in transverse section trapezoidal, more rarely triangular, whence the hyaline cells, which are more convex on the outer surface, are more or less separated from each other.

Dioicous ; ♂ branches clavate, long subulate-pointed, color light to dark red. Perigonial leaves broader and shorter than the leaves of the sterile branches. The hyaline cells in the lower half nonfibrillose and nonporose, very seldom furnished with distant, very slender, incomplete fibrils ; in the upper half with very small broad-ringed pores. Female flowers as yet unknown. Perichæatial leaves large, ovate-lanceolate, in the lower part constructed of chlorophyllose cells only, in the upper part of both kinds of cells, of which the hyaline are always nonfibrillose and often 1, 2 or 3 times divided. Capsule comparatively large, dark reddish brown. Spores dark yellow, rough with minute warts. Fruit extremely rare.

This small, delicate and extremely beautiful peat-moss is easily and certainly distinguished from the nearest related forms of the *Acutifolium* group, especially from *S. tenellum* v. Klinggr., chiefly by the remarkably small broad-ringed pores on the outside upper half of the lower and middle leaves of the spreading branches. The pores are here smaller than in any other European species, and are the more striking to the eye because they approach closely to the large pores of the lower half of the leaf almost without gradation of size. In *S. Wulfianum* also the pores are very small in the apical half of the leaf, sometimes not larger than in the present species, but they increase in size gradually and but slightly towards the base of the leaf and in its median line ; in this case the very large pores of the two flanks of the leaf contrast strikingly with the small ones of its median line.

S. Warnstorffii prefers damp or wet birch swamps, and the margins of elevated bogs when adjacent to birch-covered wet meadows; or it grows in springy swamps, here preferably in the society of *Paludella squarrosa* Ehrh. It is often found associated with *S. teres*, whilst it seems to shun the company of *S. tenellum* and the other species of the *Acutifolium* group.

This plant must surely be as widely diffused in Canada and the northern United States as it is in Europe, but hitherto, at all events, it has been overlooked or not specifically distinguished.

Var. **purpurascens** Russ. in litt. The upper part of the plants of a beautiful rose, purple or violet-red, below usually paler; with this color no green is intermixed.

N. Hampshire, Franconia, 1,000 to 1,500 ft., Lisbon, 800 ft.; Vermont, W. Burke, 1,000 ft.; Mass., N. Adams, 1,500 ft. (*Faxon*); Danvers, 100 ft. (*Sears*).

Var. **versicolor** Russ. in litt. Color of tufts a mixture of red and green; coma usually pale, rose, purple or violet-red, the middle part of the plant green or greenish, the lower part bleached out.

N. Hampshire, Franconia, 2,000 ft.; Vermont, Westmore, 1,000 ft.; Mass., Mt. Graylock, 1,500 ft., Brookline, 100 ft. (*Faxon*).

Var. **viride**, Russ. in litt. Color throughout green or greenish, with here and there a delicate flush of pale red; lower part of stem faded out.

Vermont, Willoughby Lake, 1,100 ft.; Mass., Mt. Graylock, 1,500 ft., Dedham, 75 ft. (*Faxon*).

Neuruppin, Germany, Feb. 6, 1890.

Notes on the flora of the Lake Superior region. I.

I. THE NORTHERN PENINSULA OF MICHIGAN.¹

E. J. HILL.

During the summer of 1889 a few weeks were spent in collecting and studying the flora of the Lake Superior region, with a brief stay on the way back at St. Croix Falls and Chequamegon Lake in eastern Minnesota. About two hundred species of plants were secured and have been critically exam-

¹ Read before the State Microscopical Society of Illinois, April 25, 1890.